Subject Description Form

Subject Code	EIE3100 (for 42470)
Subject Title	Analogue Circuit Fundamentals
Credit Value	3
Level	3
Pre-requisite	EIE2100 Basic Circuit Analysis EIE2102 Basic Electronics
Co-requisite/ Exclusion	Nil
Objectives	This is the main foundation subject introducing the working principles and constructions of analog electronic circuits. The specific aim is to familiarize students with the design and operation of analog building blocks (e.g., mirrors, differential stages, output stages), practical operational amplifiers, frequency response of transistor amplifiers, feedback amplifiers and oscillators.
Intended Subject Learning Outcomes	**Upon completion of the subject, students will be able to:** Category A: Professional/academic knowledge and skills 1. Understand the operations of transistor devices, e.g., BJT and MOSFET 2. Analyze the small-signal characteristics of transistor amplifiers 3. Design basic analog building blocks 4. Understand the operations and limitations of operational amplifiers 5. Analyze frequency responses and design feedback circuits and oscillators Category B: Attributes for all-roundedness 6. Communicate effectively 7. Think critically and creatively 8. Assimilate new technological development in related field
Subject Synopsis/ Indicative Syllabus	**Syllabus:** 1. Analog Building Blocks 1.1 Simple current mirrors; problem due to Early effect and non-ideality; Wilson and Widlar mirrors; use of mirrors as active loads. 1.2 Differential amplifier (DA) stage; analysis using half-circuit models, common-mode and differential-mode gains; common-mode rejection ratio (CMRR). 1.3 Output stages; class A, class B and class AB output stages; efficiency; harmonic distortions. 2. Operation Amplifier Design 2.1 Typical operational amplifier circuit: input differential stage, CE gain stage, and output stage; details of internal circuit design: active loading, level shift, current sourcing. 2.2 Non-idealities: dc offset, input bias current (causing offset); finite input impedance, etc. 2.3 Slew-rate limitation; gain-bandwidth product; stability design; concept of unity-gain feedback; phase margin; design of low-frequency pole and use of Miller effect for internal compensation. 3 Frequency Responses of Transistor Amplifiers 3.1 Parasitic junction capacitances and their effects on the current gain of transistors. 3.2 Complete high-frequency model of single-stage common-emitter amplifiers. 3.3 Derivation of first roll-off frequency (dominant pole) due to Miller effect.

4 Feedback Circuits and Oscillators

4.1 General feedback configuration; basic amplifier gain, loop gain and closed-loop (overall) gain.

4.2 Effects of feedback on gain, frequency response, distortion, input and output impedances.

4.3 Feedback circuit configurations: shunt-series, shunt-shunt, series-shunt and series-series feedback; stability analysis; phase margins and compensation methods; analysis of feedback circuits via two-port models.

4.4 Oscillation criteria; amplitude limiting and sustained oscillation; Colpitts, Hartley, Wien bridge, phase-shift and crystal oscillators.

Laboratory Experiments:

Each student is required to complete the following three laboratory experiments:

1. Title: Negative Feedback Amplifier
   Objective: To design the feedback network for a given amplifier in order to meet certain specifications.
2. Title: Oscillator
   Objective: To design a Wien-bridge oscillator using an IC amplifier.
3. Title: Characteristics of Operational Amplifier
   Objective: To study the internal operation of an operation amplifier and measure the characteristics of the responses.

Teaching/ Learning Methodology

Teaching and Learning Method	Intended Subject Learning Outcome	Remarks
Lectures	1, 2, 3, 4, 5	Fundamental principles and key concepts of the subject are delivered to students
Tutorials	2, 3, 4, 5, 7, 8	Students will be able to clarify concepts and to have a deeper understanding of the lecture material; problems and application examples are given and discussed
Laboratory sessions	3, 4, 5, 6, 7	Students in groups of 2-3 will conduct practical measurement and evaluate the performance of electronic circuits

Assessment Methods in Alignment with Intended Subject Learning Outcomes

Specific Assessment Methods/ Task	% Weighting	Intended Subject Learning Outcomes to be Assessed (Please tick as appropriate)							
		1	2	3	4	5	6	7	8
1. Continuous Assessment (total 40%)									
• Quizzes	5%	✓	✓	✓	✓	✓			
• Laboratory sessions	15%				✓	✓	✓	✓	✓
• Test	20%	✓	✓	✓	✓	✓		✓	
2. Examination	60%	✓	✓	✓	✓	✓		✓	
Total	100%								

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Specific Assessment Methods/Tasks	Remark
Quizzes	Analytical and design problems are used to evaluate students' ability in applying concepts and skills learnt in the classroom.
Test and examination	Mid-semester test is used to measure the students' ability to remember facts and figures as well as their comprehension of subject materials; Final exam is used to evaluate students' ability to think critically and creatively in order to come up with an effective solution for an existing problem.
Laboratory sessions	Each group of students is required to produce a written report; Accuracy and the presentation of the report will be assessed; Assessment of the reports will focus on both technical knowledge and ability to communicate effectively.

Student Study Effort Expected

Class contact (time-tabled):	
• Lecture	24 Hours
• Tutorial/Laboratory/Practice Classes	15 hours
Other student study effort:	
• Lecture: preview/review of notes; homework/assignment; preparation for test/quizzes/examination	36 Hours
• Tutorial/Laboratory/Practice Classes: preview of materials, revision and/or reports writing	30 Hours
Total student study effort:	**105 Hours**

Reading List and References	**Textbooks:** 1. S. Sedra and K.C. Smith, *Microelectronic Circuits,* 8th edition, Oxford University Press, 2021. **Reference Books:** 2. Paul R. Gray, Paul J. Hurst, and Stephen H. Lewis, *Analysis and Design of Analog Integrated Circuits,* 5th edition, New York: Wiley, 2009. 3. D.A. Neamen, *Microelectronics Circuit Analysis and Design*, 4th edition, New York: McGraw-Hill, 2010. 4. D.A. Jones and K. Martin, *Analog Integrated Circuit Design*, New York: Wiley, 1997.
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